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A Participatory Approach to University Teaching About Partnerships for Biodiversity Conservation

William Gladstone[†]
University of Newcastle

Robin Stanger
Urban and Wildlife Corridors Australia

Liz Phelps
National Parks and Wildlife Service

Abstract   Loss of biodiversity and habitats is one of the greatest threats to the environment and education has a critical role to play in addressing this issue. This paper describes a teaching activity for first-year university students studying sustainable resource management at the University of Newcastle which established a partnership between education, government and the community to rehabilitate a nature reserve where biodiversity values were threatened by weed invasion. Students research the problem (weed invasion), quantitatively assess the impacts of weed invasion and management interventions, and work alongside a community-based bushcare group and government agency during on-ground rehabilitation of the reserve. Key outcomes for students have been knowledge and skills relevant to a critical issue for the Australian environment; a more optimistic attitude towards environmental issues and their potential to develop solutions; a positive perspective about the role of community involvement; continued participation in community bushcare groups outside the classroom; and personal involvement in solving a critical environmental issue.

Background

Loss of biodiversity and habitats is one of the greatest threats to the Australian environment (Williams et al., 2001). In recent years, responsibility for the management and conservation of Australia's biodiversity has changed as the management emphasis has shifted from single conservation strategies such as the establishment of national parks to include broad management partnerships involving all levels of government, multiple government agencies, community groups, the private sector (individual landholders, business), and the research and education sectors (Williams et al., 2001). The emphasis on community involvement has reflected a growing environmental awareness and sense of environmental responsibility that is realised for many people

[†]*Address for correspondence*: Dr William Gladstone, School of Environmental and Life Sciences, University of Newcastle (Ourimbah Campus), PO Box 127, Ourimbah, NSW 2258, Australia. Email: william.gladstone@newcastle.edu.au

through their participation in environmental activities such as Landcare, Waterwatch, and neighbourhood bush regeneration activities (Curtis, 1998).

Environmental issues are complex and an understanding of their ecological, political, economic, and social perspectives is needed if effective solutions are to be developed. Effective environmental education must address these various perspectives (Environment Australia, 1999). Environmental education is a key action in Australia's National Strategy for Ecologically Sustainable Development (Commonwealth of Australia, 1992) and in the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia, 1996). The teaching initiative described in this paper was developed to facilitate students' understanding of the partnership model (science-government-business-community) adopted for biodiversity conservation in Australia. The teaching initiative was part of an application to Envirofund that also requested funding for contractors to undertake bush regeneration works in areas containing littoral rainforest and threatened species, to replace fences protecting sand dunes, and to install interpretative signage. Part of the application was a commitment to develop an educational initiative that involved university students in the project so they could learn the necessary knowledge, undertake some on-ground bush regeneration works in partnership with the local community, and monitor the impacts of weed removal on native vegetation. The project was a partnership between the University of Newcastle, the New South Wales National Parks and Wildlife Service (NSW NPWS), the Australian Government's Envirofund, private contractors undertaking bush regeneration in the Reserve, and a community-based bush regeneration group called Wamberal Lagoon Bush Care.

With regards to the structure of the partnership involved in this project NSW NPWS is part of the NSW Department of Environment and Conservation and is responsible for the care, control and management of the NSW national park reserve system as well as biodiversity, threatened species and Aboriginal cultural heritage management across the state. An important part of NSW NPWS's management response to the impacts of invasive weeds has been to facilitate a community response to the problem. NSW NPWS initiated the establishment of the Wamberal Lagoon Bush Care group from among the local community and supports the group's monthly bush regeneration activities in the Reserve. That support consists of the provision of training in all aspects of bush regeneration, equipment, and supervision of their work. The Australian Government's Envirofund provided financial support for a team of professional bush regenerators (Total Earth Care) to assist the community group at the beginning of the project to remove a large area of invasive weeds, thereby providing an important incentive for the regeneration to continue. NSW NPWS provided additional funding to replace fencing that protected parts of the Nature Reserve. Students and staff from the University of Newcastle provided the monitoring that assessed the effectiveness of the bush regeneration and also participated in the bush regeneration with NSW NPWS and the Wamberal Lagoon Bush Care group.

The Educational Context

This teaching was done as part of a first year semester-long course in the Bachelor of Science major in Sustainable Resource Management offered at the University of Newcastle's Ourimbah Campus. The Ourimbah Campus is located on the Central Coast of New South Wales, midway between the major urban centres of Sydney and Newcastle. On average forty students were enrolled in the course each year. The course, called Sustainable Resource Management: Natural Systems, introduced students to the ecosystem concept as a framework for environmental management, issues for Australian ecosystems, and the means of managing human interactions with

ecosystems. The course consisted of two hours of lectures and three hours of practical work per week for fourteen weeks. A major component of the practical work for the course was undertaken in Wamberal Lagoon Nature Reserve, a local nature reserve.

The Student Context

This teaching initiative operated within a diverse educational context which is relevant to the development of any education program. The participation rate of young adults from the Central Coast of New South Wales is lower than the national average (Stevenson et al., 2001). Most students enrolled in the course had no family history of participation in tertiary education. The students have been a very diverse group with ages ranging from seventeen to greater than forty years. Mature age students sometimes outnumbered high school leavers. The mature age students had returned to study after deciding upon a mid-life career change, or were studying for the first time, and they usually included a number of single parents (based on authors' interviews with students). The number of female students was greater than the number of male students in most years. In common with trends in other Australian universities, students expected a vocational-type education and frequently questioned the practicality and relevance of their education (Rickinson, 2001). The students' approach to environmental concerns varied from a history of activism to no active involvement and most students had not participated in community-based environmental or other activities (with the exception of sport). Students often expressed feelings of helplessness and pessimism to the lecturer (the senior author) about the environment in the classroom. These observations of the lecturer (based on discussions with the students) confirmed the attitudes revealed by quantitative surveys of upper high school students in Australia (Hutchinson, 1997) and elsewhere (Rickinson, 2001).

Field Site

Wamberal Lagoon Nature Reserve was gazetted in 1981 and now covers an area of approximately 140 hectares. It is the last lagoon system on the Central Coast retaining a relatively complete and intact cross-section of native vegetation across the dune system and around the lagoon (NSW NPWS, 1993). The Reserve contains large remnants of littoral rainforest (listed as an endangered ecological community in New South Wales) and important populations of the magenta lilly pilly (*Syzygium paniculatum*) (a vulnerable plant species in New South Wales) and the sand spurge (*Chamaesyce psammogeton*) (an endangered plant species in New South Wales) (NSW NPWS, 2001 and 2005)

The Reserve's 1993 plan of management described the habitats as being "undisturbed" and lists one of its features of local significance as its capacity to act as a "refuge" for native plants and animals within the highly modified surroundings of the Central Coast (NSW NPWS, 1993). However, the Reserve's potential value as a refuge has deteriorated in recent years due to the impact of fire and the rapid spread of invasive weeds. Much of the dune system has become infested with bitou bush (*Chrysanthemoides monilifera*), with smaller infestations of lantana (*Lantana camara*), cassia (*Senna pendula var.glabrata*), myrtle-leaf milkwort (*Polygala myrtifolia*), and asparagus fern (*Protoasparagus aethiopicus*) (NSW NPWS, 1993; Healthy Rivers Commission, 2002). As the overall weed infestation is so widespread in the Reserve, bush regeneration work is targeted towards alleviating the pressure from weeds on the littoral rainforest areas and on the remaining populations of the endangered sand spurge and the vulnerable magenta lilly pilly.

Theoretical Considerations

The knowledge and skills included in this teaching initiative were designed with regards to established requirements for effective environmental education (Jensen, 2000; Rickinson, 2001). Knowledge needs included a detailed understanding of the relevant ecosystems, current issues and the relevant management actions. Skill needs included the synthesis of information and its critical analysis; problem-solving; scientific investigations; the development of partnerships and of action strategies (Environment Australia, 1999, 2000). Educational research on students' experiences of environmental education initiatives has shown that, compared with in-class experiences, field experiences were highly motivational (Milton et al., 1995; Bogner, 1998) and affected greater knowledge gains and attitudinal change (Dettmann-Easler & Pease, 1999). Role modeling by teachers, via their participation in field-based activities, was an important contributor to positive attitudinal change in students (Emmons, 1997). Students' sharing of knowledge gained in fieldwork classes with the wider community increased the success of these classes (Milton et al., 1995). In a teaching initiative developed by Swiss nature conservation agencies for education about bird conservation, the combination of in-class theory, hands-on field interventions, and independent research produced significant positive effects on knowledge gains and environmental perceptions (Bogner, 1999).

The partnership approach is an effective means of managing the issues of habitat degradation and biodiversity loss in Australia. The benefits of this approach include cost-effectiveness in achieving practical conservation outcomes, a greater level of community awareness of environmental matters, and collaboration and greater understanding between government and the community (Buhrs & Aplin, 1999; Garnett & Crowley, 2000; Williams et al., 2001; Weston et al., 2003). Although the partnership approach is a relatively recent development there is a growing body of theoretical literature on the factors contributing to the success or otherwise of this approach. Particular attention has been given to the role of community volunteers. The emerging research has shown that an effective partnership with community volunteers requires professional support and management, reinforcement and communication from management agencies, and an understanding of volunteers' motivations (Miles, Sullivan & Kuo, 2000; Byron & Curtis, 2001; Safstrom & O'Byrne, 2001; Thomson & Pepperdine, 2003; Weston et al., 2003). Community volunteers provide local knowledge and participate in regenerating habitat, surveying and monitoring flora and fauna, caring for sick and injured wildlife, specialist tasks (e.g. bird-banding, collecting blood samples), communication and education, and administration (Foster-Smith & Evans, 2003; Greenwood, 2003; Weston et al., 2003; Koehn, 2004). Monitoring is essential for critically assessing the effectiveness of environmental management. However, in the case of habitat regeneration monitoring is rarely undertaken because of a lack of funding support for professionals, a lack of technical expertise by community volunteers, or a lack of interest and/or time by volunteers who may be actively regenerating large areas of degraded habitat (Freeman, 2004; Reidy et al., 2005). A potential solution to this is the participation of the education sector where students, who are learning the necessary practical skills, assist with the regeneration and undertake the necessary monitoring. It is surprising that this approach to environmental education has not been adopted more widely given the educational benefits of experiential field work, the challenges for community-based monitoring, and the opportunities for students to experience practical conservation outcomes (but see Gill (2005) for an example of tertiary students participating in a different way).

The Teaching Initiative: Objectives

Our aim was to develop a holistic teaching initiative that provided relevant knowledge and skills and reflected the current partnership approach to conserve biodiversity involving educators, scientists, government managers, business, and the community. The objectives of the initiative were:

Education

- to be a vehicle for delivering part of the required knowledge and skills for first-year students in sustainable resource management;
- to provide additional knowledge and skills perceived as being relevant by the students and potential employers; and
- to provide exposure to a real issue in sustainable resource management.

Community Engagement

- to provide students with examples of the practical benefits arising from community-based environmental activities;
- to provide a structured opportunity for students to participate in a community activity related to the environment;
- to provide an opportunity for students to interact with the community and to experience committed people; and
- to provide encouragement and support for the local Wamberal Lagoon Bushcare Group.

Attitudes

- to counteract the attitudes of pessimism and helplessness students felt about environmental issues (revealed during discussions with students at the beginning of the teaching semester) to an attitude of being able to make a difference;
- to foster an attitude of community involvement; and
- to develop in students a positive attitude about their skills and knowledge being able to make a positive difference.

Nature Conservation

- to assist in the implementation of high priority actions in the Wamberal Lagoon Plan of Management: 1) continue bitou bush control program, 2) extend introduced species control program to cover additional species; and 3) protect habitats of endangered plant species from disturbance;
- to assist the natural regeneration of vegetation communities on the dune system and enhance biodiversity; and
- to increase community knowledge and awareness about coastal dune habitat.

The Initiative: Structure

The teaching initiative consisted of the following components:

In-class Teaching that Provided Background Knowledge and Skills

Two lectures (a total of four hours) provided the necessary theory about Australian vegetation, forest ecosystem structure and function, and current management issues. Two problem-solving classes (a total of six hours) introduced students to the problem of invasive weeds, their impacts on Australian ecosystems and the economy,

weed management strategies, and Wamberal Lagoon Nature Reserve. The first class involved independent, library-based research that was directed in that students were given a list of information needs that had to be completed for the second class one week later. The exercise was structured so that students defined the problem (the impact of invasive weeds on native vegetation) and researched the means of assessing and managing the problem. Prior to the class students were offered training by library staff in information gathering. The second class occurred in a tutorial setting (fifteen students per group) where students reviewed the information they collected, checked its accuracy, and discussed the usefulness of various management strategies.

A computer-based tutorial (three hours) covered the importance of monitoring for evaluating the effects of management interventions, the role of hypothesis testing as a framework for management evaluation, data compilation in spreadsheets, and statistical tests as objective measures of effectiveness. Students worked in pairs through a series of tasks in Microsoft Excel that taught them spreadsheet design, data entry and the use of statistics to test whether hypothetical management strategies had been effective.

A practical class (three hours) was undertaken on the grounds of the University. The practical class taught skills in rapid assessment of weeds, quantitative assessment of vegetation cover by the line intercept method, map reading and use of a global positioning system (GPS). Each of these techniques was later applied in the field to assess and map the extent of weed invasion and to quantitatively assess the effectiveness of management.

Field Work at Wamberal Lagoon Nature Reserve

Weekly three-hour practical classes were undertaken at Wamberal Lagoon Nature Reserve over three weeks. Two classes involved an assessment by the students of the effectiveness of bush regeneration activities in the Nature Reserve. The assessment was done by comparing the cover of invasive weeds and native plants in areas that had received regular bush regeneration in the previous twelve months (by the local community group and bush regeneration contractors) with areas that had received a single episode of bush regeneration twelve months earlier (by bush regeneration contractors) and areas that had not undergone bush regeneration.

In each area students assessed the cover of native plants and weeds in the ground-, mid- and canopy-layers of the forest. The class was divided into three groups of approximately fourteen students per group with each group supervised by one staff member. Students collected their own data in small groups of two or three students. The same techniques in assessing plant cover learnt in the classroom were used i.e., the line intercept technique. The line intercept technique is a standard method used by plant ecologists to monitor vegetation cover (Canfield, 1941; Ludwig et al., 2000). Beginning in the ground-layer a twenty-metre tape measure was laid out over the ground. Students recorded the length of tape measure that was intercepted by native plants and by invasive weeds and converted this to a percentage of the total length of the tape measure. This was done twice more in randomly selected positions within each study area to give a total of three replicate measures. The three replicate measures were used to calculate the average cover of native plants and invasive weeds in the ground-layer. The process was repeated in the mid- and canopy-layers in each area. Each small group of students plotted the boundaries of the area with a GPS for later marking on a topographical map of the Reserve.

The final three-hour practical class at the Reserve was devoted to a rapid assessment of the extent of weed invasion throughout the Reserve. Working in the same small group students undertook rapid assessments of weed cover at fifteen sites using the Ku-

ring-gai weed index classification (KWIC) technique (Hawkesbury-Nepean Catchment Management Trust, 2000). Students visually estimated the percentage cover of weeds in the ground-, mid- and canopy-layers of the forest at a randomly selected position in each site. The percentage cover estimates for each layer were converted to a scale that reflected the severity of weed coverage. Weed coverage of less than 10 per cent was scored one, coverage between 10 and 30 per cent was scored two, coverage between 31 and 60 per cent was scored three, and coverage greater than 60 per cent was scored four. Scores for each layer were then scaled differently to reflect the ecological significance of weed invasion in the different layers of forest vegetation. Scores for the canopy-layer were multiplied by 0.5, scores for the mid-layer were multiplied by 0.2 and scores for the ground-layer were multiplied by 0.3. The final scaled scores were used to produce a colour-coded map of the extent of weed invasion, and its ecological severity, in the Reserve. Each group recorded the geographical coordinates of each site with a GPS to allow accurate mapping.

Bush Regeneration with Wamberal Lagoon Bushcare Group

Each student spent one Saturday morning working with the Wamberal Lagoon Bushcare Group accompanied by teaching staff and staff from NSW NPWS. At the beginning of the work students were instructed by NSW NPWS staff in work safety, the identification of weeds and native plants they were likely to encounter and in techniques of weed removal, weed poisoning, and planting of native seedlings. Students (in groups of ten each Saturday) worked alongside the Bushcare group members, teaching staff and NSW NPWS staff for weeding, rubbish removal, and planting.

Evaluating the Effectiveness of Bush Regeneration

In a final three-hour computer-based tutorial students utilised the computing and statistical skills they acquired in earlier classes to evaluate the effectiveness of bush regeneration as a weed management strategy at Wamberal Lagoon Nature Reserve. The results of the field assessments of vegetation cover were compiled in spreadsheets. Students used t-tests to test the hypothesis that cover of native vegetation was significantly greater, and cover of invasive weeds lower, in areas that had received regular bush regeneration by community volunteers compared to areas that had received a single episode of bush regeneration, and areas that had received no bush regeneration.

Reflection and Communication of Results

On the Tuesday following the bush regeneration students submitted a reflective diary (Biggs, 2003) that required factual responses on the work they performed, the weed species recorded, and the area weeded. Students were also required to include their personal reflections on the success (or otherwise) of the bush rehabilitation activities. Students were required to submit a written report (in the style of a scientific technical report) on the results of the monitoring and an evaluation of its effectiveness.

Outcomes

In addition to the educational outcomes of this teaching initiative (knowledge learnt, skills acquired) students gained experience in dealing with a real issue in biodiversity conservation. Their work provided a monitoring and evaluation of current bush regeneration activities at Wamberal Lagoon Nature Reserve and an up-to-date assessment of the extent of weed invasion in the Reserve. Their work resulted in a large area around an endangered ecological community being cleared of litter and weeds. A large number of native seedlings were planted.

A selection of comments from the students' reflective diaries that typify the set of responses from all students are summarised here under three themes:

1. Reality of on-ground management: "… it seems like a lot … a much greater effort will be needed to achieve appreciable results", "… results will be limited by the volunteer turnout", "Even though we cleared a lot of area for native species a lot more extensive work is needed to make an impact".
2. Community volunteers working to regenerate the Reserve: "Their enthusiasm and energy is amazing", "The group worked extremely hard", "I want to start a campus bush regeneration group for us students", "I am going to bring my children here – a great family activity".
3. Educational outcomes: "Thanks, really interesting, and useful information", "I feel like I have learnt something I can use", "I see now why we learnt the statistics", "… now understand how management should be done", "… very helpful to evaluate our own bush regeneration work".

Although not formally surveyed, all students responded very positively to this experience and most worked well in the monitoring and bush regeneration activities. Students said they felt their work had produced visible benefits for the Reserve. A number of students also felt overwhelmed by the amount of work still to be done in the Reserve, especially the area of weeds that remained. Despite this, students and their families joined their local bushcare group as a direct outcome of the experience with the Wamberal Lagoon Bush Care group and others decided to establish campus bush care group to address the weed problems occurring on campus.

Interpretive signage was installed at the main car park adjacent to the Reserve. The signage informed visitors of the work and the collaboration between the National Parks and Wildlife Service and the University of Newcastle. Articles in the print media and stories on the local television news were done annually as part of the community awareness aspect of the project. Both types of media prominently featured the involvement of the students. This public exposure of their work, and the appreciation of the community bush care group, contributed to the students' positive attitudes about this teaching experience.

A serendipitous outcome was the students' experience of the public's violation of the rules of the Reserve. On a number of occasions students observed people walking dogs in the Reserve in spite of this activity being prohibited (signs advising people that dog walking was prohibited were prominently displayed at the entrance to the Reserve). Students also witnessed rangers unsuccessfully requesting these people to remove their dogs from the Reserve. All students who observed these offences reflected in their diary about the poor attitudes displayed by the dog owners and the difficulties of managing people's behaviour.

Students who had always lived in the area were surprised and pleased to discover the beauty of the Reserve. They were also dismayed at the extent of the weed invasion and its impacts and thanked the teaching staff for providing that experience. Although monitoring of bush regeneration projects has often been recommended (Williams et al., 2001) there are little or no resources for this to be implemented. Consequently, any monitoring, especially long-term monitoring, has remained outside the scope of many projects. Integrating monitoring of community projects into the Sustainable Resource Management coursework has provided a valuable and cost-effective answer to this problem. It has also revealed that the outcomes, in terms of the benefits to native species, are comparable to other community-based bush regeneration projects with a similar investment of volunteer effort (Reidy et al., 2005).

Student involvement has also resulted in a realistic understanding of the enormity of the problem and the financial commitment required to ameliorate such issues. Students developed an understanding that it is simply not enough to talk about issues and condemn agencies for their apparent lack of response to environmental issues. Their proactive response has engendered change directed towards principles of ecologically sustainable development.

This teaching approach is applicable in other locations and for other examples of environmental activities involving community volunteers. Partnership activities are occurring throughout Australia and most require monitoring (Freeman, 2004). This need can be met, with careful planning and training, by an educational activity such as the one described in this paper. There will be benefits for the teaching, the students, the partners in the environmental activity, and the environment. This teaching initiative required careful planning as it was to be integrated into an existing partnership. Planning between staff from the university and NSW NPWS began approximately six months before the start of teaching. This was necessary to obtain the approval of the community group for the students to participate, to decide on the tasks that students could perform alongside the more experienced community volunteers, to obtain the necessary permit from NSW NPWS authorising the teaching to occur in the nature reserve, and to prepare the necessary occupational health and safety guidelines for the students. A timetable of teaching activities was planned with the NSW NPWS staff three months before the beginning of teaching, which ensured there was no conflict with their other work responsibilities. A barbecue at the end of a Saturday morning's work proved to be a useful opportunity for students to speak with the community volunteers and NSW NPWS staff about their activities. Students have been provided with detailed step-by-step instructions about the use of simple statistical tests for hypothesis-testing, as this has presented a particular difficulty for many students. The importance of techniques to objectively assess management effectiveness is stressed throughout the instructions provided to students. Our experience has shown that this is best taught in a tutorial setting where students have personal access to staff for assistance.

Conclusion

Education about biodiversity conservation at the University of Newcastle has benefited from the partnerships established with National Parks and Wildlife and the local community. This teaching initiative, in addition to being a satisfying and rewarding learning experience for the students, contributed in practical terms to the conservation of a local nature reserve. The teaching initiative developed among students a greater connection to nature and an awareness of the possibility of a personal contribution to biodiversity conservation through their own actions and by collaborating with community-based activities. The partnership between community, government agencies and education provided a response to an environmental problem which seemed too big for any one group to tackle alone.

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